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ABSTRACT

The purpose of the experiment was to test the prediction that non-specific facilitated learning of a second prose passage will occur in the situation where an initial passage read by the subjects contained concrete referents designed to increase the comprehension of a difficult to understand second passage. Two-hundred and forty subjects distributed equally in twelve groups read either two successive experimental passages or a control passage followed by an experimental passage and then recalled all of the information they could from the second passage. The results offer substantial support for the predictions and contain implications for enhancing the learning of educational materials. (Author)

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Facilitated Learning in Connected Discourse[1]

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Facilitated Learning in Connected Discourse

The purpose of the experiment was to test the prediction that non-specific facilitated learning of a second prose passage will occur in the situation where an initial passage read by the subjects contained concrete referents designed to increase the comprehension of a difficult to understand second passage. Two-hundred-forty subjects distributed equally in twelve groups read either two successive experimental passages or a control passage followed by an experimental passage, and then recalled all of the information they could from the second passage. The results offered substantial support for the predictions and contain implications for enhancing the learning of educational materials.

Facilitated Learning in Connected Discourse

David Ausubel (1963, 1968) has frequently argued that many of the principles established in the long history of list learning research are not applicable to learning from connected discourse. A case in point is Ausubel's (e.g., 1965) general contention that appropriate cognitive structures, once learned, should facilitate subsequent learning and retention, and further, that this facilitation should be independent of the sources of specific transfer identified for list learning. Previous attempts at demonstrating non-specific facilitated learning with connected discourse have been equivocal (e.g., Ausubel, Robbins, & Blake, 1957; Ausubel, Stager & Gaite, 1968; Wong, 1971). The reader is refered to Anderson & Myrow (1971) and Cunningham (1972) for reviews of this literature. The purpose of the present investigation was to identify at least one condition under which such facilitation will occur.

To our knowledge there are no studies which conclusively demonstrate non-specific facilitated learning of a second passage as a function of exposing subjects to material contained in an initial passage. However, there are several studies which demonstrate non-specific facilitated learning of a passage as a function of making reference to information the subject already knows. For example, Dooling and Lachman (1971) presented subjects with highly metaphorical passages concerned with Christopher Columbus' discovery of America and man's first flight to the moon. Subjects who were informed of the theme of the passages prior to reading them recalled significantly more words from the passages than did subjects not informed of the theme.

Similar transfer effects were found in several experiments reported by Bransford & Johnson (1972). One additional experiment (Bransford & Johnson, 1971) is noteworthy because of a failure to find enhanced recall as a function of presenting subjects with the theme of a passage. Bransford & Johnson (1971) had their subjects listen to a passage which described the activities of a man as he shaved, had breakfast, and left his home in the morning. Subjects informed prior to hearing the passage that the man was unemployed did not perform differently than did subjects not given this information. An examination of the passages from these studies (i.e., Dooling & Lachman, 1971; Bransford & Johnson, 1971; Bransford & Johnson; 1972) suggests that the unemployed man passage, unlike the other passages, contained considerable thematic content. In contrast, the remaining passages (where the theme effect was present) contained sentences which were ambiguous without knowledge of the specific theme. The implication of this for the present study is that facilitated learning of a second passage as a function of reading an initial passage is likely to occur only when the second passage material is not easily related to existing knowledge structure.

Given the above suggestion, a further question arises: What is the nature of an initial passage which will lead to facilitated performance on a second passage? A recent experiment by Pezdek & Royer (1972) suggests a possible answer to this question. The Pezdek & Royer study was concerned with an outcome initially reported by Begg & Pavio (1969). Begg & Pavio aurally presented subjects with abstract and concrete

sentences and then asked their subjects to respond same or different to the original sentences, sentences changed in meaning, or sentences changed in wording. The outcome of the study was that subjects recognized wording changes in abstract sentences better than meaning changes, and they recognized meaning changes in concrete sentences better than wording changes. Johnson, Bransford, Nyberg, & Cleary (1972) argued that this outcome was the result of inadequate comprehension of the abstract sentences. Proceeding on the same assumption, Pezdek & Royer (1972) attempted to demonstrate that detection of meaning changes in abstract sentences could be enhanced by embedding the sentences in paragraphs designed to increase the comprehensibility of the sentences. An example of one of the abstract sentences and the context paragraph is listed below (the target sentence is in capital letters):

> The foreign-exchange student from India spoke to an attentive high school assembly Wednesday. Much of her talk revealed the fact that Buddhism was a major guiding force in her life. THE FOREIGN FAITH AROUSED AN ENDURING INTEREST.

The paragraphs used in the Pezdek & Royer (1972) study were specifically designed to provide concrete referents for the material contained in the abstract sentences. As predicted, meaning changes in the abstract sentences were more easily detected when they were embedded in the paragraphs.

Combining the results cited above, the following predictions for the present experiment were made. Facilitated learning of a second prose passage as a function of reading an initial

passage is most likely to occur in the instance where, 1) the material contained in the second passage is difficult to comprehend, and 2) the material in the initial passage contains concrete referents which will facilitate the comprehension of the second passage information.

Prior to testing the above hypotheses, a preliminary step was necessary. It is clear that any study purporting to demonstrate non-specific facilitation in prose learning must demonstrate that the facilitation is not a function of specific transfer sources (cf. Anderson & Myrow, 1971; Myrow & Anderson, 1972). Unlike previous experiments (Anderson & Myrow, 1971; Crouse, 1971; Myrow & Anderson, 1972) which examined specific transfer effects by constructing the passages so as to reflect specific similarity and difference relationships, the present study empirically identified portions of second passage learning which were subject to specific transfer effects.

Experiment I

The purpose of Experiment 1 was to identify material in a second passage that was subject to specific transfer effects as a function of reading an initial passage. Eight experimental groups read an initial passage and then filled in the blanks in a mutilated version of a second passage (Cloze procedure, Taylor, 1953). Four additional control groups completed the Cloze task without reading an initial passage. The logic behind the comparisons made was that specific effects should be detectible by comparing Cloze task performance of the experimental groups with that of the control groups. Thus, any significant deviations

from control group performance (positive or negative) were taken as evidence that specific transfer effects were present.

Method.

Materials. The materials for the experiment consisted of two versions of each of two passages. The first passage was concerned with the flow of heat (H) through metals, and the second with the conduction of electricity (E) through metals. The subject matter of the passages was chosen for two reasons. First, the material should be relatively unfamiliar to the subject population with which the experiment was conducted, and second both the flow of heat and the flow of electricity through metals are affected by the same properties (i.e., pressure, impurities, temperature, and magnetism). The effects of these properties in turn, are understandable given some knowledge of the atomic and molecular structure of metals.

These similarities allowed construction of the passages in the following way: Both passages began with a short introductory segment concerned with the specific phenomenon (i.e., heat flow or electrical conductivity). This segment was followed by a description of the internal molecular and atomic structure of metals (e.g., crystalline lattice arrays, free-floating electrons, etc.). This description was reasonably similar in the two passages. The description of internal structure was followed by a discussion of factors which affected the flow of heat, or the flow of electricity, through the metal. In the H passage this consisted of a description of how pressure on the metal, and the presence of impurities in the metal,

affected the heat conducting properties of the material. In the E passage the text described how temperature and the presence of a magnetic field affected the flow of electricity through the metal. Thus, each passage consisted of a unique discussion of the phenomenon, a similar description of the internal structure of metals, and a unique description of the properties which affect the flow of heat or electrical conductivity.

Both the H and the E passages were written in "concrete" (C) and "abstract" (A) versions. In the C versions of the passages physical analogies for the internal structure of metal and the effects of the previously mentioned factors (e.g., magnetism) were constructed and included in the text; thereby providing concrete referents for much of the material contained in the passage. For example, in the HC passage the effect of an impurity in the metal was presented as being analogous to the effect of placing a sizable object such as a pack of cigarettes in a row of toppling dominos-the result being an impedance to the orderly transfer of energy. In contrast, the A versions of the passages were written so as to be as devoid of concrete referents as was possible. The word length of the various passages was as follows: HC-912, HA-780, EC-684, EA-672.

The complete texts for each of the four passages described above were also prepared in two mutilated versions, each of which involved the removal of every fourth noun or adjective.

Version 1 began the removal process at the second noun or adjective in the passage, and version 2 began the removal at the fourth noun or adjective. Using two versions of the mutilated passages allowed performance assessments on the majority of the material contained in the passages while restricting the tedium of the blank-filling task to reasonable levels.

Design and subjects. There were 12 groups in the experiment, with twenty college undergraduates randomly assigned to each of the groups. Eight of the groups initially read the non-mutilated versions of the passages described in the previous section (i.e., HA, HC, EA, EC). Upon completion of this reading task, the subjects were presented with a mutilated version of a second passage differing in content. So, for example, forty subjects initially read the complete version of the HA passage. These subjects were then divided into two groups of twenty, one of which received the mutilated version of the EC passage, the second receiving the mutilated version of the EA passage. In addition to the eight groups formed by the procedure described above, there were four groups (controls) which received the mutilated versions of the four passages without being exposed to an initial passage. The mutilated versions of the passages were balanced such that half of the subjects in each group received version 1, the remaining half version 2.

Procedure. The subjects were run in groups ranging in size from five to fifty. Upon appearnace for the experiment the subjects were given an envelope containing the experimental

materials. These envelopes had been randomly arranged prior to the experiment such that several conditions were represented at each of the experimental sessions. The subjects in the experimental conditions were instructed to remove the complete version of the passage contained in their envelopes and to read the passage slowly and carefully twice. When all of the subjects had finished reading the passage they were instructed to remove the mutilated version of the second passage from their envelopes. These versions had been prepared in booklet form such that approximately three sentences appeared on each page of the booklet. The subjects were instructed to go through the booklet filling in all of the blanks they could with the appropriate word. They were encouraged to guess at those blanks they were not sure of, and instructed not to turn back to a booklet page once that page had been passed. The subjects in the control conditions were given special instructions concerned only with the blank filling task.

Scoring and analysis. The data of interest in the experiment was the proportion of blanks correctly filled in for each of the groups. These proportions were computed for each of the blanks contained in the passages and were based on performance by every subject in a particular group. A blank was considered correct if it was filled in with the exact word from the original passage, or a synonym for that word.

When the proportions correct on each blank were computed, the performance by the experimental groups was compared against performance by the control group receiving the same

mutilated passage. The comparisons consisted of Z tests for the difference between two proportions (Walker & Lev, 1953, p. 77.) performed on each blank contained in a passage. The null hypothesis was rejected at the .05 level.

Results. From the total of 1122 comparisons between experimental and control group performance on the cloze task, 29 were found to differ significantly. Eleven of these were advantages favoring the control group (indicating negative transfer), the remaining 18 were advantages favoring the experimental groups (indicating positive transfer). The possibility of some Type I errors (as opposed to Type II) in these comparisons is justified by the experimental need to identify specific transfer material. Type I errors would not adversely affect the test of predictions in Experiment II.

We have previously indicated that the passages were constructed so as to contain three parts: a unique description of either heat flow or electrical conductivity (approximately 13% of the material contained in the passages), a section similar in both the heat and electricity passages describing the internal structure of metals (approximately 47% of the material), and a section unique to a particular content passage describing factors which affect heat flow or electrical conductivity (approximately 40% of the material). If there were any validity to the use of the cloze tasks as a detector of specific transfer, then the majority of the significant differences should come from the similar-content section of the passages. In fact, the middle sections of the passages containing the similar content con-

tributed 86% (25) of the significant comparisons. The unique sections each contributed two significant comparisons.

Twenty-one of the 29 significant comparisons were contributed by subjects receiving the mutilated abstract passages. Twelve of these came from subjects in the abstract-abstract conditions and nine from the concrete-abstract conditions. The eight remaining significant comparisons were distributed such that two came from the concrete-concrete conditions and six from the abstract-concrete conditions.

Experiment II

The purpose of Experiment II was to test the predictions that facilitated learning of a second passage would occur only in the situation where subjects received a concrete (C) initial passage and an abstract (A) second passage. No facilitation was expected in any of the conditions involving the C passage as the second passage because the C passages were presumably comprehensible in and of themselves. The A-A condition was predicted to be non-facilitating because the initial passage did not contain concrete referents which would aid in the comprehension of the second passage.

Method.

Materials. The experimental passages were the same as those described in Experiment I. Only the complete versions of the passages were used. In addition to the experimental passages, an unrelated passage of similar length (concerned with the differences between myths and legends) was used as a warm-up passage for the control groups.

Design and subjects. The design for the experiment is presented in Table 1.

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Insert Table 1 about here

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Twenty college undergraduates were randomly assigned to each of the twelve groups.

Procedure. Prior to the experiment the materials were placed in envelopes which were then randomly arranged. The experiment was run in groups ranging in size from five to fifty and, upon appearance, each subject was given one of the envelopes. The subjects were asked to remove the first passage from the envelopes and to read the passage slowly and carefully twice. When all of the subjects had finished reading they were asked to replace the first passage and to remove the second passage. They were then told they would have two minutes to read each of the three pages in the passages. When each of the two minute periods had elapsed, the subjects were asked to turn the page, and were reminded not to turn back to the previous page. When the reading period had elapsed, the subjects were instructed to replace the passage in the envelope and to write down everything they could remember from the second passage they had studied. They were given as much time as they desired for this recall task.

Scoring and analysis. The dependent variable of interest in the experiment was the proportion of recalled "idea units". Each of the passages was subjectively parsed into idea units by

the authors. The number of idea units contained in each of the passages was as follows: concrete heat flow-78, abstract heat flow-67, concrete electricity-55, abstract electricity-52.

Each of the recall protocols was scored for the presence of the idea units by an undergraduate assistant who was naive to the purposes of the experiment. Thirty-six of these protocols (three from each group) were randomly selected and scored blindly by the second author. The inter-scorer reliability coefficient for this sample was .98.

Three different dependent variables were analyzed in the experiment. The first was the proportion of correctly recalled idea units. A second analysis was performed on the proportion of correctly recalled idea units after having removed (for analysis purposes) those idea units on which there was evidence of specific transfer. This was done in the following way. Any idea unit which contained a blank on which the experimental groups (in Experiment 1) performed significantly better or worse than did the control group was removed from the scores of subjects receiving that passage as a second passage. For example, say that subjects in Experiment 1 who received the concrete heat passage first, followed by the mutilated version of the concrete electrical conductivity passage, performed significantly better (or worse) on a particular blank than did control subjects receiving the same passage. The idea unit which contained that blank would then be ignored for analysis purposes for all subjects receiving the concrete electrical conductivity passage as a second passage.

The third dependent variable was the proportion of correctly recalled idea units (with removal of specific transfer material) from the unique factor portion of the passages. That is, the latter portion of the passages considered factors which affected the flow of electricity or heat (e.g., impurities, magnetism.) These factors were unique to a specific content passage, and therefore probably less subject to specific transfer than some of the other material in the passages.

Results.

Twelve separate analyses of variance were performed on the data. Since the four passages (i.e., HA, HC, EA and EC) differed somewhat in length, the analyses were performed with groups receiving the same second passage. Each analysis was performed with the three dependent variables mentioned in the previous section, resulting in the total of twelve analyses. The mean proportion of correctly recalled idea units for all groups on the three dependent variables are presented in Table 2.

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Insert Table 2 about here

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The analysis of subject performance on the concrete second passages revealed that there were no significant transfer effects with any of the three dependent variables (i.e., whole passage scores, corrected scores, and unique factor scores).

The comparisons in further analyses were between groups receiving the abstract heat flow passage as a second passage

and the groups receiving the abstract electrical conductivity passage as a second passage. An analysis of the proportion of correctly recalled idea units from the total passage indicated that there was significant transfer in the analyses of the heat flow passage, $F(2,57)=16.4, p<.01$, and the electrical conductivity passage, $F(2,57)=15.1$, $p<.01$.

These analyses were repeated using the specific transfer-corrected scores and the unique factors scores as dependent variables. The corrected scores analysis indicated that there was a significant transfer effect in both the heat flow ($F=15.8$) and the electrical conductivity analyses ($F=12.1$). Similar statistical conclusions were reached in the unique factors analysis (Fs were 15.0 and 15.4 for the H and E passages, respectively).

Discussion.

The results of Experiment 2 supported the original hypotheses. The subjects in the concrete-abstract conditions recalled significantly more material from both the heat and electricity second passages than did the subjects in the abstract-abstract and control-abstract conditions receiving the same passages. The robustness of these facilitory effects are particularly noteworthy. The minimum gain in recall noted for subjects in the concrete-abstract conditions was 40 percent above that noted for the next highest group receiving the same second passage (see Table 2). In addition, the groups that received the concrete second passages did not differ significantly in their recall of either the heat or electricity passage materials.

The sources of the facilitory transfer effects noted in the experiment are not discernible at this time. An answer to this question would require that we have knowledge of the form and structure of memory representation. It could be the case, for example, that the concrete analogies we presented to our subjects resulted in the formation of imaginal representations that the subjects could manipulate as an aid in comprehending subsequently presented abstract material. If this were true, then it should be possible to demonstrate even more pronounced facilitory effects by embellishing the provided text with actual pictures. It should be noted, however, that imaginal memory representation is not the only possibility. Pylyshyn (1973) has noted that there are at least three other representational theories in existence. The identification of the specific sources of facilitory transfer other than those identified in the list learning literature are undoubtedly going to await the development of a viable theory of memory representation.

One aspect of the data that deserves mention is the generally high level of recall for subjects in the concrete-abstract conditions. An examination of the data in Table 2 reveals that subjects in these conditions generally recalled a higher proportion of the abstract passages than did the subjects recalling concrete second passages. This outcome is counterintuitive given the assumption (supported by the performance of the control groups) that the concrete passages should be easier to learn than the abstract passages. Our interpretation of this effect is that it is due to the degree of effort that the subjects put into processing the material. The argument is that, given the

appropriate cognitive structure (established by studying the concrete initial passages), subjects had to expend more effort in processing the abstract passages than they did in processing the concrete passages. This effort, in turn, increased the proportional amount of material learned from the two types of passages. Battig (1972) has described similar kinds of effects in list learning research and Bobrow & Bower (1969) and Anderson, Goldberg, and Hidde (1971) have demonstrated the facilitory affects of processing effort in sentence learning.

Despite the difficulty in ascribing the transfer effects noted in this experiment to specific sources, we feel that the study has important pedagogical implications. A logical next step in a program of research would be to determine if the effects noted in this study hold with genuine instructional materials which students have demonstrable difficulty in learning. Preliminary learning materials could then be prepared in accordance with the concrete referent notions contained in our passages to determine if learning of the difficult materials could be enhanced.

In addition to the confirmation of the original predictions, we feel that the present study contains an important methodological innovation. The innovation being the use of a cloze task in Experiment 1 to assess the degree and source of specific transfer in two successively learned prose passages. The importance of this procedure is that investigators can use this technique to assess the degree of specific transfer in extant passages, rather than constructing rather artificial passages that reflect specific similarity and difference relationships.

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Footnotes

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[2]During the completion of this research the second author was supported by NSF Development grant GU4041

Table 1

Design for Experiment 2

Group	No.	First Passage Type of Passage	No.	Second Passage Type of Passage	Recall
1	A	Heat Flow	C	Electricity	2nd passage
2		Electricity		Heat Flow	2nd passage
3	A	Heat Flow	A	Electricity	2nd passage
4		Electricity		Heat Flow	2nd passage
5	C	Heat Flow	C	Electricity	2nd passage
6		Electricity		Heat Flow	2nd passage
7	C	Heat Flow	A	Electricity	2nd passage
8		Electricity		Heat Flow	2nd passage
9	Myths and Legends		C	Electricity	2nd passage
10	Myths and Legends			Heat Flow	2nd passage
11	Myths and Legends		A	Electricity	2nd passage
12	Myths and Legends			Heat Flow	2nd passage

Table 2

Mean proportion of recalled idea units for the three dependent variables.

Type of second passage	Treatment	Dependent Variable whole passage corrected scores	unique factors segment
Heat Flow	C - C[a]	.23	.22	.32
	A - C	.24	.23	.35
	M - C	.27	.26	.32
	A - A	.19	.20	.16
	C - A	.33	.32	.35
	M - A	.22	.21	.17
Electrical Conductivity	C - C	.21	.21	.20
	A - C	.25	.24	.27
	M - C	.29	.29	.24
	A - A	.20	.18	.13
	C - A	.36	.35	.43
	M - A	.22	.25	.19

[a]The letters correspond to: C=Concrete, A=Abstract, M=Myths and legends